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OVERVIEW OF INDUSTRY AND UTILITY  
DECISION CRITERIA FOR PARTICIPATION  
IN GEOTHERMAL HEATING APPLICATIONS

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## I. INTRODUCTION

Building on DOE's progress in identifying and ameliorating barriers on the supply side of the geothermal equation, the Earl Warren Legal Institute's focus for FY 1979-FY 1980 shifted to the demand side: Who are the potential end-users of geothermal heat? What decision factors will determine their energy choices? How will these choices be made, and by whom? What are the implications for the structuring of a commercial geothermal industry? Where can government policy most effectively address user concerns and influence the development of such an industry?

This paper presents an overview of the results of five major surveys undertaken by the Institute among potential industrial users and public utilities in an effort to answer these questions.

(i) User Industry Survey. On the industry side, we conducted an extensive interview program with some 60 firms in four industries commonly targeted as viable geothermal heating candidates. Our interviewees represented a cross-section of firms engaged in greenhouseing, lumber drying, chemical production, and potato and onion processing. Our inquiries focused on these firms' current fuel use patterns and future supply concerns; their present knowledge of the potential for geothermal use in their industries; their decision criteria for plant site selection; their interest in locating plants near resources and in utilizing geothermal fluids which might be discovered in proximity to their operations; and their possible willingness to undertake exploration and development of the resource to satisfy their process heat needs.

To assist in targeting DOE's policy planning and program efforts, we investigated industry sources of information and managerial

procedures for planning and evaluating investments in new technology, and identified key participants in decisions to convert to geothermal, and the criteria which they would apply to such decisions.

This work resulted in four comprehensive reports evaluating the prospects for geothermal use in these industries.\* They represent the first systematic empirical studies focusing on the needs and perceptions of commercial/industrial heat users, and provide an indispensable reference for policy planning directed to the realistic concerns of potential geothermal users. The reports were formally presented to DOE headquarters in April 1980, and have since received wide distribution and favorable comment among the geothermal community. Section II below synthesizes the central findings of these four studies and suggests some of their implications for future development.

(ii) Public Utility Survey. Responses to our user industry survey compel the conclusion that, while many firms would welcome the opportunity to utilize geothermal heat if they could obtain it as simply as they now obtain conventional fuels, very few of them would be able or willing to undertake exploration or development of the resource, or to distribute spent fluids for use by others. To encourage commercial uses, then, someone else must perform these

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\*See: Prospects for Geothermal Commercialization in the Lumber Industry; Prospects for Geothermal Commercialization in the Greenhouse Industry; Prospects for Geothermal Commercialization in the Potato and Onion Industry; Prospects for Geothermal Commercialization in the Chemical Industry (Earl Warren Legal Institute, 1979-80).

essential functions. Many have assumed that existing public utilities--experienced in energy production, transmission, distribution, marketing and customer service--are the logical candidates to undertake these activities.

To probe this assumption, we designed and conducted a similarly comprehensive survey of existing gas and electric utilities in states known to have geothermal potential. Our objective was to determine their interest in developing and/or distributing geothermal for direct heating applications, the business and regulatory constraints which would affect their decisions in this area, and the types of government measures necessary to encourage their participation.

The 34 utilities interviewed included almost all of the major investor-owned utilities in the western states, and a representative selection of publicly owned municipal, district and rural utilities. We explored whether these utilities had considered the possibility of supplying geothermal heat for direct uses, and how such an interest had developed or why it had not. We examined their willingness and ability to undertake resource exploration and field development, and their potential role as distributors of geothermal fluids supplied by others, and sought to define the conditions critical to utility decisions in each of these areas. We also probed such questions as the relationship of utility interest in geothermal electric generation to the prospect of utility participation in direct heat applications; the preferred

terms of geothermal fluid sales contracts; and the probable impact of various regulatory and programmatic initiatives in inducing or discouraging utility participation.

The results of this work were formally presented to DOE headquarters in April 1980 and are set forth in detail in our report entitled "The Role of Gas and Electric Utilities in Direct Applications of Geothermal Resources" (March 1980). In response to numerous requests, we have also distributed this report to state utility commissions and legislative staff, as well as to members of the geothermal development community. Its findings and conclusions are summarized in Part III, below.



## II. USER INDUSTRY STUDY

It has generally been assumed that rising energy costs in industries with substantial low-temperature process heat needs will induce increasingly widespread geothermal use, so long as technical feasibility and cost advantage can be demonstrated. However, few systematic attempts have been made to determine how industry management and technical personnel within these industries view this possibility in light of factors they deem important to their own firms' energy supply choices.

This study examined that subject in relation to potential commercial geothermal use in the greenhouse, lumber, chemical, and potato and onion processing industries. Its results are based on interviews with decision-makers in some 60 firms representing various segments of these industries.

### A. Current Fuel Patterns and Concerns

Present fuel patterns and practices and anticipated responses to perceived fuel problems vary by industry. Some industries are seriously affected by rising energy costs and are thus more interested in a broader range of alternative energy sources; but some can pass on cost increases, utilize internal energy resources, or take conservation measures which diminish energy concerns.

Based on preliminary engineering analyses, it appears that

geothermal energy could substitute for fuels used for space heat in greenhousing, for steam heat in lumber drying and veneer and plywood processing, for some process heat in ammonia, chlorine/caustic soda and salt production, for blanching and peeling potatoes and for dehydrating onions. Our survey shows that the primary fuel currently used for these processes is natural gas, except in the lumber industry, which is rapidly converting from oil and natural gas to the use of wood waste for most energy needs.

It is commonly assumed that the ratio of fuel cost to total cost of operations is an important indicator of potential interest in geothermal use. Among the industries surveyed, the ratio varies from one to another and also within some industries depending on the product mix. The range is from 5% to 85% of total costs. The highest energy consumers among chemical firms sampled are the chlorine/caustic soda and nitrogen fertilizer producers, and among vegetable processors, producers of potato flakes and dehydrated potatoes and onions.

However, these circumstances do not necessarily correlate with interest in geothermal energy. For example, in the production of nitrogen fertilizer, 50% of the energy cost is for feed stock for which geothermal energy cannot substitute. And while chlorine/caustic soda producers have high energy costs in relation to total costs, part of this reflects the cost of supplying high temperatures needed for a variety of chemicals produced in a complex chemical plant, and these firms' primary interest is in resources for electricity

generation. On the other hand, greenhouse growers sampled have a much lower energy/total cost ratio but show more interest in geothermal because it is more compatible with their basic energy needs. Thus, it appears that while high energy consumption influences fuel choices, other factors need to be considered.

Tolerance of fuel supply interruptions is one such factor. This also varies from one industry to another and within industries. In most of the industries surveyed, the consequences of fuel supply interruptions are considered serious enough to induce almost all firms to provide back-up systems. Precise temperature control is critical to product survival in greenhouse and potato flake production. Among most chemical firms surveyed, start-up time is usually so lengthy as to make unscheduled shutdowns very costly. On the other hand, providing steam heat for lumber drying and veneer processing is a fairly simple operation; because wood waste is a plentiful fuel for these processes and because interruption would not destroy the product, no back-up is considered necessary.

In spite of provisions for fuel interruptions, these firms generally do not expect serious supply curtailments. Back-up systems are considered necessary because of fuel supply interruptions which occur periodically in most areas, but few consider the interruptions as ominous. Most respondents indicated that an inadequate fuel supply more than any other factor would force them to look for alternative energy sources, but also felt that, while natural gas may become increasingly expensive, supplies will be adequate in the near future.

Rising fuel costs were a source of serious immediate concern among almost all the firms in all industries surveyed. The responses to price escalation were consistent within each industry but differed significantly from one industry to another. Lumber producers have an immediately available alternative in wood waste, which is particularly attractive because it is internally produced. These firms are almost universally shifting from the use of natural gas and other fuels to wood waste for steam heat needs. This trend is limited in the short run only by the inability of some firms to meet expensive pollution control requirements, and by the reluctance of utilities to purchase excess power from companies interested in cogeneration to improve the economics of wood waste utilization. For these companies, government implementation of PURPA §210 (requiring utility power purchases from cogenerators) can be expected to increase interest in wood waste as a heat source, perhaps at the expense of geothermal alternatives.

In the chemical industry increased fuel costs also have induced some firms to seek substitutes. However, the search is primarily for energy sources with high-temperature potential. Moreover, many chemical processes produce sufficient waste heat to make heat recycling an obvious and attractive alternative for serving lower temperature needs.

The greenhouse industry has responded in two ways to rising fuel costs. Most firms recently began converting to polyethylene thermal blankets as greenhouse cover to conserve heat and thus reduce

fuel consumption. Secondly, some indicated that they can pass on increased costs to their customers, and several indicated they could accommodate doubling or even trebling of fuel costs in this way before considering alternative energy choices.

Potato and onion processors appear to be in the least satisfactory position to deal with energy cost increases. Unlike other industries, they have no internal energy resource, little conservation potential and an inelastic product demand which makes it difficult to pass on cost increases. For these reasons, they are very interested in alternative energy generally, and because many potato firms are located near areas of good resource potential, they have given serious consideration to geothermal use.

#### B. Plant Siting Requirements

Resource location was considered by all industries to be the primary factor inhibiting geothermal use, because the large majority of firms surveyed would not relocate simply to take advantage of a geothermal resource even if it offered some cost savings. While some would consider locating new plants to take advantage of an available resource, most state that other considerations have priority. Lumber firms, potato and onion processors and some chemical sectors are heavily dependent upon the location of raw materials for plant siting, while greenhouse growers are more concerned about transportation, product markets, labor and water supply.

Factors Influencing Plant Location\*

<u>Factor</u>	<u>MI</u>	<u>VI</u>	<u>I</u>	<u>TOTAL</u>	<u>NI</u>
Raw Material Supply	19	9	4	32	3
Close to Product Market or Transportation	4	20	7	31	1
Energy Supply	2	21	2	25	2
Water Supply	2	9	6	17	-
Labor Supply	3	6	8	17	-
Climate	1	-	3	4	1
Waste Disposal	-	2	1	3	-
Air Quality	-	1	-	1	-

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\*MI = Most Important; VI = Very Important; I = Important;  
NI = Not Important

While most firms in all industries interviewed see available energy supply as very important to plant siting, the picture is more complicated than simply comparing energy costs among locations. Energy supply needs can be met in many locations, and plant location plans will focus first on requirements for which there is no substitute. Geothermal will therefore be attractive only where it can offer lower energy costs at a site where the other basic requirements are met.

C. Commercialization Potential

Knowledge of the potential for geothermal direct use varied widely from one industry to another in the survey. At one extreme, over half the potato and onion processors had considered using geothermal energy. At the other, only those few lumber companies located near commercially exploited geothermal resources were even aware

of direct use potential. Chemical producers were generally aware only of geothermal electric potential. Almost all greenhouse operators knew that geothermal is used for space heating in their industry but, like lumber producers, only those near commercially exploited resources had more specific information.

Knowledge of actual costs for geothermal development and use was extremely limited except among potato processors. However, skepticism prevailed among all industries concerning its cost competitiveness with conventional fuels.

Assuming adequate cost information, it does not appear that the high capital investment associated with geothermal use is necessarily the barrier one might expect. Given a choice between investments with high initial costs and low operating costs or ones with low capital requirements and higher operating costs, many companies would prefer initial high capital costs for several reasons: tax advantages, long-range cost certainty and inflation protection. Furthermore, many firms are indifferent to cost distribution as long as annualized costs are the same. The firms which would prefer low capital costs do so because of cash flow problems, because they need greater investment flexibility or because the company has a policy of minimizing debt. However, some undercapitalized industries such as greenhousing have limited choices, and for these firms high initial capital costs may indeed pose a barrier to geothermal use.

Another common assumption has been that possible unreliability of geothermal resources poses a significant barrier to commercial use. The survey indicates that this factor may be less important than imagined in many instances. While reliability of supply is extremely important in greenhousing, potato flake production and some chemical processing, it does not present new problems for these industries. As noted earlier, most firms in all industries surveyed already follow a convention of providing back-up for primary fuels.

However, a different sort of barrier did emerge in the survey. There appear to be dominant trends in some industries which detract from consideration of other energy alternatives. As noted above, the lumber industry is focusing almost exclusively on wood waste, even though geothermal energy might well suit some of its energy needs. Among greenhousers, conservation by insulation is the prevailing idea. In the chemical industry heat recycling and electric quality resources dominate energy thinking. Geothermal promoters are therefore confronted not only with the problems associated with introducing an unfamiliar energy source, but also with the problem of obtaining a hearing where other energy strategies have taken hold.

Perhaps the most significant barrier to commercial geothermal use to emerge from the survey relates to the prospect of user development of the resource. Among the industries studied, there is a near total lack of interest in exploring for low-temperature resources, a strong reluctance to participate in development and an overwhelming preference to purchase energy of any sort through a distribution system



managed by others. The few companies willing to explore for geothermal tend to be large chemical companies who are already in the energy business, or potato or lumber companies near known resources which have already been exploited. The attitude of those who might consider field development activity is no more venturesome. They generally require that the resource be well established, that there be very little risk of drilling a dry hole, and that the resource be near their existing plants. Otherwise, companies are most likely to consider using geothermal energy when someone can offer it to them through a distribution system in much the same way that they receive other existing energy supplies.

### III. PUBLIC UTILITY STUDY

Given the preferences of potential users, the establishment of geothermal distribution systems appears to be essential to the growth of a commercial direct heat market. It has commonly been assumed that existing utilities will play a central role in this area. Until recently, however, the utilities' own views on this subject had not been systematically examined. The purpose of this study was to conduct such an examination. The material summarized here is based on in-depth interviews with executives and managers representing 34 utilities, including most of the major gas and electric companies and representative smaller private and publicly owned utilities serving western geothermal areas.

#### A. Overall System Considerations

One basis for the belief that utilities will be motivated to undertake geothermal distribution is the assumption that such projects will relieve demand pressures on their gas and electric systems or will defer the need for expensive new power generation capacity. The survey responses show that this assumption does not accurately reflect current utility perceptions.

The greatest system pressures are being experienced by electric utilities, whose need for generating capacity is determined by the highest level of daily and seasonal electricity demand. Increasing costs, more stringent regulation and public opposition have made it difficult for utilities to meet rising peak demand by constructing

new power plants. In most western states where gas is the primary fuel for space heating, peak electric demand is on summer afternoons. The anticipated use of geothermal for space heating would not affect this peak or the need for new generating capacity to meet it. On the other hand, the use of geothermal for space cooling could impact peak electric demand. However, utilities in this region do not view geothermal heating as an answer to their electric system pressures, because they do not foresee cost-effective geothermal space cooling as a near-term prospect.

The demand picture differs in the Northwest. Washington and Oregon electric utilities have winter peaks, largely due to electric space heating demand. In these states geothermal use for space heating could theoretically reduce peak demand. Nevertheless, with a few notable exceptions, these utilities are no more interested than those in other regions. They do not look to geothermal to relieve system pressures because most doubt that direct applications will ever be large enough to have a significant impact on their power generation capacity requirements.

The gas utilities surveyed generally view geothermal as direct competition to gas sales with no offsetting system benefits. Although many experienced supply shortages during the past decade, most gas systems now have ample supplies. However, they are facing reduced markets caused by sharply rising prices, conservation and the loss of industrial customers. Geothermal heating services might therefore interest them if they appeared to offer a means of retaining or regaining the business of large industrial energy users who are converting

from gas to other fuels. Even where customers cannot be regained, where a geothermal resource is identified, local gas utilities may be forced to choose between undertaking geothermal distribution or losing additional gas markets to others who will exploit the resource.

Another assumption has been that electric utilities involved in geothermal power generation will be interested in developing downstream direct uses for spent power plant fluids. This interest was confirmed. Most of the utilities are enthusiastic in principle about downstream uses as a way to improve the economics of geothermal power production. However, a number of potential problems raised by utilities may in actuality limit the early development of downstream uses.

One is the remote location of many electric-quality resources. Although the utilities hope that industries will be willing to move to take advantage of this energy source, other indications are that relocation to remote areas is fairly unlikely. The user studies discussed above conclude that very few firms will relocate to take advantage of the availability of geothermal energy, and that the siting of new plants will be based much more strongly on access to raw materials, markets, labor and transportation than on particular energy sources.

Another problem is that power plant engineering considerations may dictate that no usable heat will remain for other uses. In any case, many utilities believe that downstream uses should not be

developed until the recharge requirements of the power plant reservoir have been fully determined. In addition, there is uncertainty about whether the utility which is generating power will control the spent fluids, or whether they will remain the property of the resource producer.

#### B. Participation in Exploration and Development

The responses indicate that most privately owned utilities are unlikely to play an important role in exploration and development for direct heat applications. They consider high-risk investments in basic exploration to be inappropriate, since regulatory commissions would not allow the costs of failures to be passed on to ratepayers and utility shareholders are traditionally interested only in very safe investments.

Some companies which have previously invested in exploration for electric-quality resources have since withdrawn from resource development because of the high risks. They now contemplate building power plants only where a resource has been proved by others. On the other hand, Pacific Gas and Electric Company, which has been the pioneer in geothermal power production but has not previously participated in resource development, has now decided to explore for resources outside of The Geysers. Nevertheless, although some electric utilities are willing to participate in exploration for resources suitable for their basic business of power generation, few would consider taking these kinds of risks for direct applications. Gas companies, with

experience in exploration and development of natural gas resources, appear somewhat more willing in principle to consider resource development for direct uses.

However, only one among the investor-owned utilities surveyed reported that it would initiate and carry out geothermal exploration on its own. This was Northwest Natural Gas Company, which for several years has been actively seeking a resource on Mt. Hood to serve large industrial customers near Portland, Oregon. The others would most likely participate in geothermal resource development, if at all, only in joint ventures initiated by major resource companies which would carry most of the risk and the financing burden.

Some companies which would not actively explore for geothermal for direct uses might still invest in field development of a known resource. One reported that it might develop a hot water resource discovered during its exploration for oil and gas. Similarly, electric companies that are seeking electric-quality geothermal resources might consider developing a low-temperature resource discovered during the course of their exploration. However, because of the remote locations of most of the drilling, this is unlikely to lead to significant development for direct applications. In addition, much of the exploration for electric-quality resources is outside the utility service areas. Most utilities are not interested in developing resources for direct applications in such cases (even though they might consider developing downstream uses for the spent fluids of power plants located outside of their territories). Even inside

its service area, a utility might prefer to encourage potential users to develop the resource rather than to develop the field itself for direct applications.

The publicly owned utilities surveyed had a more positive attitude toward participation in resource development, but only where a local resource has been clearly identified by past exploratory work. None expected to go far outside its service area or to seek new resources. The public districts and municipal utilities were also more willing than the private companies to consider acting alone in resource development. While some would look for development partners among other public entities or potential users, only a few would limit their participation to joint ventures with resource companies (and many of the municipal utilities would reject such an arrangement).

However, development financing may present a serious constraint for these public utilities. Normal tax-supported bond financing may not be feasible, given present constitutional and political limitations. Many utilities also have the authority to issue revenue bonds, but it is questionable whether there would be a market for revenue bonds issued to finance the development risks of a geothermal distribution project.

#### C. Interest in Distribution Activities

In contrast to their hesitation to participate in resource development, almost all of the utilities surveyed would be willing to consider becoming retail distributors of geothermal heat if an

independent resource producer could supply hot water near a populated section of the utility service area. All utilities see their experience and facilities for delivering energy, billing and servicing customers and operating under regulation as relevant. They point out that gas companies in addition have useful technical expertise relating to underground pipelines, as do a number of utilities which operate steam or hot water systems serving downtown areas or large building complexes.

For privately owned utilities, a geothermal distribution proposal would be evaluated as a new business venture. Most large companies would find such a proposal attractive only if they could see the prospect of large geothermal operations, on a scale that fits the size and centralized management perspectives of the company as a whole. These companies are unlikely to undertake a small distribution project, no matter how cost effective it might appear as a separate venture, unless they have first made a companywide decision to enter the field of geothermal direct applications on a large scale.

Smaller utilities, both privately and publicly owned, would generally be willing to consider any proposal without regard to questions of overall scale, and could undertake even small local projects if they appeared cost-effective.

Financial evaluation of a direct heat project would also differ between privately and publicly owned utilities. Most investor-owned utilities would find a geothermal project attractive only if



it could be expected to earn a higher return than conventional utility investments. This is both because they need an incentive to undertake a new line of business and because they anticipate serious operational problems and risks in working with geothermal. However, the ability to earn such a premium may be limited. Utilities generally expect that geothermal distribution will be subject to public utility regulation. Some believe that their state utility commissions may not recognize the need for a higher return on geothermal investments and may restrict the return on utility-operated geothermal systems to the rate allowed on utility gas and electric facilities.

Publicly owned utilities, on the other hand, would tend to require only that a direct-use project meet the financial standards applied to other utility investments, which may range from earning a substantial return to operating at break-even. Since municipal utilities are departments of local government, evaluation and decisions on geothermal projects will be made on the basis of more than strictly business concerns. Many communities may be willing to accept lower returns on investment for the use of local, alternative energy resources, or for projects that can aid local economic development.

#### D. Fluid Sales Contracts

When geothermal distribution is based on hot water supplied by an independent producer, the terms of the sales contract between the producer and the utility purchaser will be important. Utilities have definite views on how this contract should be structured in several important respects. Most of the investor-owned utilities

would accept a purchase price based on market value and pegged to the price of alternative fuels. Most of the publicly owned utilities would strongly prefer a price based on the costs of production which would not escalate with the price of OPEC oil. But they would expect the price to include a substantial "risk rate of return" on the producer's investment. For many utilities certainty of price is even more important than the beginning level: they would want a provision limiting the allowable price escalation during the course of the entire contract.

Among other contract terms, almost all utilities would accept a take-or-pay provision under which they would guarantee a level of minimum purchases. Some would also want the contract to contain specific provisions for exclusive dedication of the resource or requiring the producer to continue exploration and development of the geothermal field.

The issue raising the most concern among utilities is the risk of premature reservoir depletion. Some utilities would require the producer to guarantee the delivery of fluids, at least for a certain period of time, with liability to reimburse the utility for any unrecovered investment if the quality or quantity of the fluids falls below the contract levels. Others see the possibility of reservoir depletion as more of an "act of God," and would accept a part of the risk. Most would pass on the risk to the geothermal customers through rapid amortization of the utility investment. A few utilities expect that the government must bear the risk through reservoir insurance or non-recourse loans in order to facilitate geothermal development.